

the Mechanics



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OCTOBER 1959

NO. 1



Rush Hour Traffic in Washington, D. C.

**SCHOOL OF ENGINEERING
THE GEORGE WASHINGTON UNIVERSITY**

OCTOBER 1959



The shape of flight

The shapes of things that fly have always been determined by the materials they are made of. Feathers form wings that are basically alike for all birds—and membrane forms an entirely different wing for insects. It takes thousands of years, but nature improves its materials and shapes, just as technology improves the materials and shapes of aircraft. But here, the improvements in materials are so rapid that designs become obsolete almost as soon as they are functional.

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HELP WANTED

The greatest problem faced yearly by this magazine probably stems from the small size of the Engineering School that it represents. Each issue must contain at least three and preferably four feature length articles. The authors of this material should be you, the students and alumni of the School of Engineering. In the past, the staff of Mecheleciv has experienced great difficulty in obtaining these articles. Full time students apparently have their hands full with studying and classes, and the plaintive cries from the struggling editors have gone unheeded. Part time students either don't know this need for articles or are too busy with work and night school.

In an effort to increase the flow of articles, the Engineers' Council, which acts as the Board of Publishers of Micheleciv, and controls the purse strings, has offered \$5.00 for each full length article submitted by a student at George Washington University which is printed in the magazine. In addition, the author of the best article printed during the semester will receive an additional \$25.00. Second and third prizes will also be awarded.

Any student or alumnus of the University may submit an article on any topic, but preference, of course, will be given to articles of scientific interest. To be considered, articles should be at least 1,000 words in length, and typed or written legibly.

COUNCIL'S CORNER

Dear Fellow Student:

On behalf of the student body of the School of Engineering, I would like to welcome all the freshmen and transfer students to G. W. As you take part in all the activities of the school you will come to realize as those before you that this is an excellent engineering school. But more important than this you will learn quickly that you receive from school only as you give to it with all your ability.

We of the Engineers' Council are anxious to be of full service to all students whether you be full-time or part-time, whether you are a graduate or undergraduate. There are a few areas in which we know what we must do in the coming school year. However, if the council is to use its position profitably, you, the student, must make known to us your ideas for improvement of the school. In order that we may act concerning your problems, you must first let us know what these problems are.

The Engineers' Council is now in the process of completing a student directory of all engineering students. A little later in the semester you will receive School of Engineering book covers.

Remember you gain from the school only as you give it. Likewise, the council can serve you best when you bring your problems to it.

Sincerely,
RAY HOWLAND
President

Traffic Control In The District of Columbia

by JOSEPH H. BANTA

If you felt there was a great unseen power controlling your life while driving to school you weren't entirely wrong. In fact, you had no power over your movement until that automatic traffic light told you to go.

The traffic signals in the District of Columbia are composed of one-way signal bodies grouped on suitable arms to form two, three, four, five and six-way signals. Each body can be separately adjusted to enable the signals to be pointed directly at the traffic lanes which they control. The arrangement and number of signal faces can be altered to fit changing requirements. The most common mounting found in the District of Columbia is post mounting.

The operation of traffic signals is determined by local conditions. Five types of operation are used by the District of Columbia:

1. Flashing Signal: Continuously flashing red and yellow signals, used on streets of low traffic volume.
2. 24-Hour Signal: Employed continuously on streets of high traffic volume during the full 24-hour period. An example of this type of operation can be found on the main arteries such as Route 1, passing through the city.
3. Special Hours Signal: Used on streets with a high traffic volume during one period and a low traffic volume during another period.
4. Special Signal: Special directional arrows, no left or right turn signals, and bridge signals are operated as needed.
5. Pedestrian Signal: The neon pedestrian signals are of the constant illumination type. This type of signal is operated in conjunction with the traffic signals at the intersection.

A secondary controller is used at each intersection installation to operate the signals. Three commercial firms manufacture signal controllers for the District of Columbia. Controllers manufactured by General Electric, Crouse-Hinds, and Eagle have the same basic operating principles.

The secondary controller consists of three major parts: A timer, a panel, and a weatherproof cabinet. The timer consists of three dial units and solenoid-operated drum. Only one of three dials operates the drum at a time. The timing dial of a dial unit is driven by a

synchronous motor through a change gear. One or more rotations of the timing dial produces one full revolution of the drum, depending upon whether the interval sequence is broken out one or more times on the drum. Rotation of the drum, in turn, causes the signals to change from one color interval to the next and so pass through one complete interval sequence.

The length of one complete time cycle is determined by the size of the change gear that is installed. The percentage of the time cycle that is allotted to each interval is determined by the spacing between the keys in the timing dial. Each key advances the drum one position. The particular lights that are displayed during each interval are determined by the cam breakout on the drum.

Because there are 100 slots in the timing dial, the lengths of the several intervals that make up the interval sequence are adjustable in one percent steps.

As each key in the timing dial passes the 12 o'clock position, it momentarily closes a set of contacts. The unpainted keys close the drum-advance contacts; the key painted green closes the drum-release contacts.

When the drum is in step with the dial, closure of either of these sets of contacts energizes the drum solenoid and thereby causes the solenoid plunger to move downward. As the key moves beyond the 12 o'clock position and the contacts open, the solenoid is immediately de-energized and a spring pulls the plunger upward to its de-energized position. As the plunger moves upward, a pawl, mounted on a crank attached to the plunger, engages a tooth on the ratchet and advances the drum one step.

The signal-light contact arms that control the circuits to the several lamps in the traffic signals bear against the cams on the drum. Each contact arm closes its circuit wherever a cam segment is broken out and opens its circuit when an unbroken segment moves the arm away from its stationary contact.

The basic controller is of the non-interconnected type. These controllers are used at isolated intersections. The controller is driven by a high-torque synchronous motor. Therefore, the controller will keep in time with the frequency of the power supply circuit. This makes it possible to control signals at adjacent intersections and

(Please turn to page 27)

ELEMENTARY MATRIX ALGEBRA

by WAYNE DAVIS

If there's ever a world of filterless cigarettes—one with no "thinking men"—we will have the theory of matrices to thank, for there would be no mechanical "brains" to help man without this device.

The theory of matrices, introduced into mathematics by Cayley in 1857, presented an organized method for the solution of systems of linear differential equations. It is a compact, flexible notation useful in dealing with linear transformations. Interest among physicists was aroused in 1925, when Heisenberg, Born, and Jordan discovered its usefulness in the study of problems in quantum mechanics.

Vast amounts of literature dealing with various applications of the new theory to mathematics, physics, and engineering, have since been produced. Its wide application is dramatically demonstrated by a survey, published in a book by Wedderburn, 1936, where 661 references are cited.

Translated into practical terms, the theory of matrices has lead to the development of digital computers, where the easy performance of fundamental operations was readily adapted to the machine. There is, of course, a natural application to many branches of engineering. Theories in elastic structures, electric circuits, wave propagation, and mechanical vibrations are formulated concisely with matrices, and practical numerical results may be obtained using matrix algebra.

BASIC DEFINITIONS:

A matrix is a set of "mn" quantities arranged in a rectangular array of "m" rows and "n" columns. Usually denoted:

$$\begin{bmatrix} a_{11} & a_{12} & \dots & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & \dots & a_{2n} \\ \dots & \dots & \dots & \dots & \dots \\ \dots & \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & \dots & a_{mn} \end{bmatrix} = (a) = A$$

The symbol "A" or (a) denotes the entire array of elements. The individual quantities or elements of the array are denoted by a_{ij} , where "i" may be $(1,2,3,\dots,m)$ and "j" may be $(1,2,3,\dots,n)$. Hence, a_{16} denotes the element in the first row of the sixth column. A rectangular matrix of "m" rows and "n" columns is a matrix of order (m, n) , where "m" and "n" are integers. If $m=n$, it is square. If all the elements of a

matrix are zero, it has rank zero. If a matrix has a square sub matrix of order "r", which is non-singular, but every square sub matrix of order "r+1" is singular, then the matrix has rank "r".

PRINCIPAL TYPES OF MATRICES:

A *row matrix*, line matrix, or row vector is a set of "n" quantities arranged in a row and, therefore, is a matrix of order $(1,n)$.

A *column matrix*, or column vector is a set of "m" quantities arranged in a column, and is a matrix of order $(m,1)$.

A matrix of order $(1, 1)$ is often identified with the corresponding ordinary number or *scalar*.

A *diagonal matrix* is a square matrix in which all the elements off the main diagonal are zero (eg: $a_{ij}=0$, if $i \neq j$). The main diagonal runs from the upper left corner to the lower right corner. It is often denoted: diagonal $(b_1, b_2, b_3, \dots, b_n)$.

A unit or *identity matrix* is a diagonal matrix when the non-zero elements are equal to unity.

The *transpose* of a matrix is formed by interchanging rows and columns. Hence:

$$(a) = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \end{bmatrix} \quad (a)_t = \begin{bmatrix} a_{11} & a_{21} \\ a_{12} & a_{22} \\ a_{13} & a_{23} \end{bmatrix}$$

A *symmetric matrix* is square and symmetrical about the main diagonal. Hence: $(a)_t = (a)$, but if $(a)_t = (-a)$ the matrix is skew symmetric.

DEFINITIONS AND FUNDAMENTAL ALGEBRAIC OPERATIONS:

The *determinant* of a matrix is the determinant of the elements of a square matrix.

A *singular matrix* is a square matrix for which the determinant of its elements is zero. If the determinant is not zero, then the matrix is termed non-singular.

The *cofactor* of the element a_{ij} of a square matrix is the determinant formed by the elements after deleting the "i-th" row and the "j-th" column (called the minor of a_{ij}) multiplied by $(-1)^{i+j}$.

The *adjoint matrix* of a square matrix is formed by replacing each element by its cofactor and transposing. It is usually denoted: $\text{adj } (a)$.

Two matrices are *equal* if they are of the same order and corresponding elements are equal. (eg: $a_{ij} = b_{ij}$)

Addition (and subtraction) of two matrices is defined by the operation:

$$(a) + (b) = (c)$$

where:

$$a_{ij} + b_{ij} = c_{ij}$$

MATRIX MULTIPLICATION:

To multiply a matrix by a scalar, we multiply all the elements of the scalar thus:

$$k(a) = (b)$$

where:

$$b_{ij} = ka_{ij}$$

It is noted that scalar multiplication is commutative, that is:

$$k(a) = (a)k$$

Two matrices are called *conformable* matrices when the number of columns of the first is equal to the number of rows of the second. Two matrices may be multiplied together if, and only if, they are conformable. The product of two matrices—(a) of order (m,p) and (b) of order (p,n)—is defined as:

$$(a) (b) = (c)$$

where:

$$c_{ij} = \sum_{k=1}^p a_{ik} b_{kj}$$

Hence:

$$(c) \text{ is of order } (m, n)$$

Matrix multiplication is not commutative except in special cases. If two matrices of the same order are said to commute (sometimes called permutable matrices) then:

$$(a) (b) = (b) (a)$$

A unit matrix commutes with a square matrix of the same order. The product (a) (b) is referred to as:

- (a) multiplied on the right by (b), or
- (b) multiplied on the left by (a)

A column matrix multiplied on the left by a row matrix, following the rules outlined above, results in a scalar or a matrix of order (1, 1).

A square matrix multiplied by a square matrix of the same order results in another square matrix of the same order. A row matrix of order (1, p) multiplied on the left by a column matrix of order (r, 1) results in a rectangular matrix of order (r, p). A square matrix, when multiplied on the right by a column matrix, results in a row matrix. With the exception of the noncommutative laws of multiplication, all of the ordinary laws of algebra apply to matrices. It may be easily verified that the associative law holds—

(a) (b) (c) = (a) [(b) (c)] = [(a) (b)] (c)
if (a) and (b), and (b) and (c) are conformable matrices.

SOLVING OF LINEAR EQUATIONS SIMPLIFIED WITH MATRICES:

Matrices may also be used to simplify systems of linear equations. Two systems of "n" linear equations, in "s" unknowns, are called *equivalent* if every solution of one system is also a solution of the other system. We can obtain an equivalent system if:

- a) two equations are interchanged,
- b) an equation is multiplied by any scalar which has an inverse,
- c) an equation is replaced by itself, plus any scalar times any other equation.

By considering the *augmented matrix* of the system, it can be shown that if the matrix is of order (r, r+1), the solution can be found by performing these operations on the matrix. In the final matrix—"G" in the illustration—the square matrix, formed by the first "r" columns, is an identity matrix and the solution is presented in the (r+1)th column. To illustrate, consider the following three equations in three unknowns:

$$\begin{aligned} x - 2y + 3z &= 6 \\ x - y - z &= -4 \\ 2x + 3y + 5z &= 23 \end{aligned}$$

The augmented matrix is formed by deleting the variables x, y, z, and the equality signs:

$$A = \begin{bmatrix} 1 & -2 & 3 & 6 \\ 1 & -1 & -1 & -4 \\ 2 & 3 & 5 & 23 \end{bmatrix}$$

- a) replace row "2" by row "2" minus row "1"
- b) replace row "3" by row "3" minus two times row "1"

We have now:

$$B = \begin{bmatrix} 1 & -2 & 3 & 6 \\ 0 & 1 & -4 & -10 \\ 0 & 7 & -1 & 11 \end{bmatrix}$$

- c) replace row "3" by row "3" minus seven times row "2", which gives:

$$C = \begin{bmatrix} 1 & -2 & 3 & 6 \\ 0 & 1 & -4 & -10 \\ 0 & 0 & 27 & 81 \end{bmatrix}$$

- d) multiply row "3" by 1/27

$$D = \begin{bmatrix} 1 & -2 & 3 & 6 \\ 0 & 1 & -4 & -10 \\ 0 & 0 & 1 & 3 \end{bmatrix}$$

- e) replace row "1" by row "1" minus three times row "3"

- f) replace row "2" by row "2" plus four times row "3"

$$E = \begin{bmatrix} 1 & -2 & 0 & -3 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 3 \end{bmatrix}$$

(Please turn to page 27)

Vibration

Measuring Instruments

by STEVEN A. THAU

The problem of eliminating vibrations from rotating machinery was formerly left to the care of men having little knowledge of vibration theory, but who depended on their senses of sight, touch, and hearing and practical shop or field experience for solution. However, increasing dimensions and velocities in modern machinery requiring the compilation of *quantitative* data, it has become necessary to develop instruments capable of giving very exact information concerning vibratory motion.

The fundamental data to be measured in investigating this problem are: (a) frequency of the vibration, (b) amplitude, (c) the type of wave (simple harmonic or complex), and (d) stresses produced by the vibrations.

This article gives a description and the basic principles of several simple instruments whose purpose is to measure either frequency or amplitude of vibratory motion.

First let us consider the simple single degree of freedom system of figure 1:

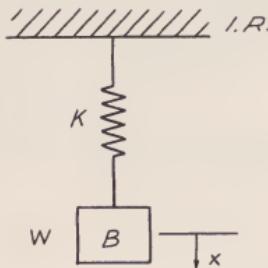


Figure 1—Single degree of freedom system
I.R. is the inertial reference point of the system.

K is the spring constant of the system, defined as the force produced by the spring per unit elongation of the spring.

W is the weight of the vibrating body "B".

x is the relative displacement of B with respect to the inertial reference.

Due to the weight of B, the spring will be stretched by an amount which is called δ_{st} .

$$(1) \delta_{st} = W/K$$

If the weight is now displaced a distance x, the spring will be stretched by this amount and from Newton's second law:

$$(2) \Sigma F_x = \frac{W}{g} \frac{d^2x}{dt^2}$$

thus,

$$(3) -Kx = \frac{W}{g} \frac{d^2x}{dt^2}$$

or,

$$(4) \frac{d^2x}{dt^2} + \frac{Kg}{W} x = 0$$

now let

$$(5) p^2 = \frac{Kg}{W} = \frac{g}{\delta_{st}}$$

and then the solution of equation 4 will be:

(6) $x = C_1 \cos(pt) + C_2 \sin(pt)$
and the *natural* frequency of the motion will be:

$$(7) f = \frac{p}{2\pi} = \frac{3.127}{\sqrt{\delta_{st}}}$$

cycles/second.

If we had subjected the inertial reference to a periodic motion of the form,

(8) $u = u_0 \sin \omega t$,
then eq. (2) would become:

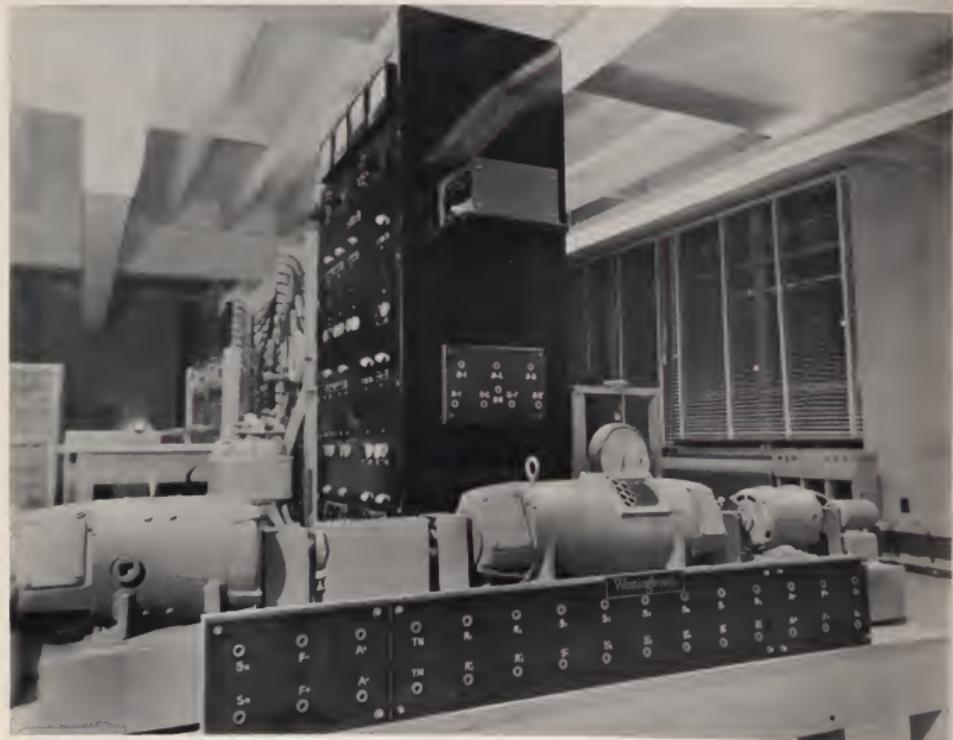
$$(9) -K(x-u) = \frac{W}{g} \frac{d^2x}{dt^2}$$

or,

$$(10) \frac{d^2x}{dt^2} + p^2 x = p^2 u_0 \sin \omega t$$

New Power Lab Equipment

Westinghouse Donates Generalized Machine as Part of Nationwide Program



The newest piece of apparatus in the Electrical Engineering Department's Power Lab is a Generalized Machine made by the Westinghouse Electric Corporation. This remarkable machine is so designed that it can simulate the characteristics of any type of electromechanical energy conversion device. Emphasizing the unity of rotating machinery principles, it provides a unified framework in which the student can relate all electrical machines.

The concept of the generalized machine was developed by two M.I.T. professors, D. A. White and H. H. Woodson, to illustrate the principles of the electromechanical energy conversion course that they were teaching as a part of the curriculum. Since then this approach to machine analysis has become so widespread that the

need for this type of machine has prompted the Westinghouse Corporation to produce the unit now in the laboratory.

This year, 150 of these generalized machine laboratory units are being donated by the Westinghouse Educational Foundation to the major electrical engineering schools in the United States. This unit is a much improved version of the crude efforts of the original designers, who had to improvise from existing machinery. The decision by Westinghouse to build this machine followed a symposium on the new electromechanical energy conversion course, sponsored by the National Science Foundation.

The generalized machine was presented to the school by Mr. C. H. Rice, electric utility sales manager, on



behalf of Westinghouse, and was accepted on behalf of the University by Dean Martin A. Mason of the Engineering School. Also present were Dr. Ernest Frank, Executive Officer of the Electrical Engineering Department, Professor Norman B. Ames, and other members of the staff.

As students taking Power Lab this semester already know, the machine is being used for several experiments this semester, and will be utilized even more in the spring.

The generalized machine laboratory set is made up of four main parts. The central component is the generalized machine itself. The stator is a standard two-pole two-phase winding. The rotor and the brush carriage are coaxial and can be rotated separately; each can be locked in the desired position with respect to the frame, and the other rotated in either direction at the desired speed.

The rotor is driven by a shunt d-c motor which also acts as load when the generalized machine is run as a motor. Between the generalized machine and the driving motor is an instantaneously indicating torquemeter. The

torquemeter operates on the principle of magnetostriiction, and comes complete with transistorized power source and amplifier.

The brush carriage is driven by a small d-c shunt motor which is also equipped with a tachometer. The tachometer is electrical, and is a small generator located at one end of the machine set.

The two phase a-c is obtained from a transformer which is wound for three phases on the primary and two on the secondary. The school was already equipped with one of the transformers; this one had been designed by some students several years ago in one of Prof. Ames' design courses.

The remarkable versatility of this machine can be seen when it is realized that all of the experiments performed in the Power Lab, with the exception of those involving transformers, control systems, and special instruments, can be performed on this one machine. By comparing the results from different hookups of this single machine the student can get a better picture of the unity of the basic principles which apply equally for all electrical machines.

Metal quiz... you might have to take one like it again when you design equipment. Try your hand at it now. But remember to take advantage of the help INCO can give you when really tough metal quizzes come your way in your future engineering jobs.



Refinery valve—Needed: resistance to attack from petroleum products, thermal and hydraulic shock. Which alloy... ?



Turbojet afterburner shell—Needed: strength plus corrosion resistance at high temperatures. Which alloy... ?



Recovery tower—Needed: resistance to hot coke oven gases and aromatic chemicals, long service life. Which alloy... ?



Diesel manifold—Needed: scaling and oxidation resistance at 1200°F, resistance to thermal shock. Which alloy ?



Heat treating retort—Needed: light weight, ability to endure destructive heating-cooling cycles. Which alloy... ?



Ship's propeller—Needed: lighter weight and resistance to erosion and salt water corrosion. Which alloy... ?

See if you can tell which of these nickel-containing alloys proved to be the answer to these problems. Put the right number in the right box.

- 1 Ductile Ni-Resist*
- 2 Nimonic "75" nickel-chromium alloy
- 3 Nickel-aluminum bronze
- 4 Ductile iron
- 5 Monel* nickel-copper alloy
- 6 Inconel* nickel-chromium alloy
- 7 Type 316 chromium-nickel stainless steel

See answers below



Regenerator pre-heater—Needed: trouble-free service handling hot caustics, fabricating ease. Which alloy... ?

When you start to design equipment, you'll have to select the proper material to meet given service conditions... a material that might have to resist corrosion, or wear, or high temperatures, or a combination of these conditions.

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in many such problems. Inco's List "A" and List "B" contain descriptions of 377 Inco publications which are available to you, covering applications and properties of Nickel and its alloys. For Lists "A" and "B", write Education Services.

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ANSWERS:

- Refinery valve...Ductile iron
- Turbojet afterburner shell...Nimonic "75"
- Recovery tower...Type 316 stainless

- Diesel manifold...Ductile Ni-Resist
- Heat treating retort...Inconel alloy
- Ship's propeller...Nickel-aluminum bronze
- Regenerator pre-heater...Monel alloy



Inco Nickel

makes metals perform better, longer

Magnetic Amplifiers

by H. D. BECK

Probably no other control devices have ever received a more rapid acceptance than magnetic amplifiers. Since World War II, these devices have been widely applied in industrial and military equipment.

As is characteristic of other amplifying devices, magnetic amplifiers are capable of modulating large amounts of power in response to small control signals. Tiny outputs of photocells, thermocouples, vacuum tubes, and small relays are used to govern the delivery of thousands of horsepower. Extremely fast response and a high degree of accuracy characterize magnetic-amplifier regulating systems.

Their rapid acceptance stems chiefly from their reliability. Because there are no moving parts or electronic tubes, maintenance problems for these units are virtually non-existent when the units are properly applied.

Voltage, current, speed, torque, position, frequency, and tension are only a few of the quantities that can be controlled with magnetic amplifiers. Application of these devices have been made in almost every industry, and they now govern many of the functions formerly controlled by rotating and electronic amplifiers as well as mechanical regulators. In other applications, magnetic amplifiers supplement rotating amplifiers and electronic controls, and thereby extend the application possibilities of these well known devices.

How do these magnetic amplifiers work? Let us consider the case of a simple idealized amplifier.

The amplifier circuit as shown in figure 1 consists of a single core and a rectifying element. Alternating currents induced in the control winding by transformer action from the power windings may be suppressed by a choke coil as shown.

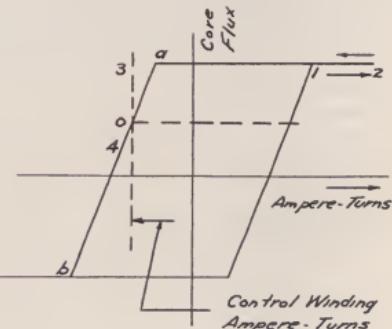


Figure 2

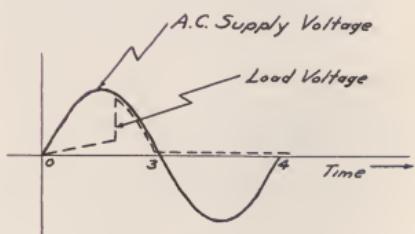


Figure 3

Now let us consider figures 2 and 3. The core material for the reactor is assumed to have an idealized hysteresis loop. An operating point 0 can be established at any point on the saturation curve by the d.c. ampere-turns in the control winding. As the a.c. applied voltage increases on its positive half cycle, an opposing and almost equal instantaneous voltage is induced in the power winding over that portion of the cycle during

(Please turn to page 30)

Electrons and Electron Tubes

by L. A. BARNES

Electronics deals with the behavior of electrons, especially when they are contained inside vacuum or gas-filled tubes. Electricity is more often thought of as the behavior of electrons contained in conductors. Basically there is no difference between electronics and electricity. Electronics specializes in the use of certain devices; however, it is based on the same fundamental principles as electricity.

The uses of electronics are becoming more important every day and are found in all the engineering fields. Radio, radar, television, X-ray, and photoelectric cells are a few of the uses of electronics, and electron tubes.

The Edison Effect—In 1883 Thomas Edison was experimenting with his recently invented carbon filament incandescent lamps. He discovered that when he inserted a wire or metal plate into the top of his lamp and current was turned on, an electric current flowed from the hot filament to the wire or plate. The bulb also glowed with a blue light. The current was large only when the wire or plate was connected to the positive terminal of the filament. The transmission of current between the plate and filament, which was heated, is known as the Edison Effect. Thomas Edison patented his device. However, he did little with it and eventually his patent ran out.

Actually, Edison had invented what we know today as the thermionic diode. This term means that electrons were given off by a heated filament and are received on a positively-charged plate. The tube had only two elements.

The Fleming Valve was the next step in the development of electron tubes. In 1904 Sir John A. Fleming, an Englishman, applied the principles of the Edison Effect to detecting radio signals. The Fleming tube was called a valve because it allowed current to pass in only one direction. When the filament was negative and the plate was positive, a current flowed between filament and plate. But when the filament was positive and the plate negative, no current could flow. Therefore, the tube could be used to change alternating current, which moved first in one direction and then in the other, to direct current which moved in one direction only. When the current passed in one direction it was allowed to pass through the tube. When it moved in the other direction it was blocked by the tube.

Electron tubes are still used for changing alternating current into direct current. Every radio set operating on alternating current has such a tube. It is called a rectifier. Rectifiers are also used in industries, such as

electroplating and in changing alternating current to direct current for use in X-ray machines.

DeForest Audion Tube. During 1907 Lee DeForest, an American, added a third element to the tube and made it even more useful. He inserted a grid, or small screen, of wire between the heated filament and plate. This grid made it possible to control the flow of electrons passing from filament to plate. Some scientists make an analogy between the grid and a venetian blind. It regulates the passage of electrons from grid to plate as a venetian blind regulates the passage of the sun's rays. As the grid is made more negative, less electron current can flow, because like charges on the electron and the grid repel each other. The DeForest tube was the first amplifier built.

Modern Electron Tubes. The DeForest tube could only be used with small signals and voltages. It required many improvements to amplify large currents and voltages as is done today. One of these improvements was to produce greater vacuums. Also in the modern tubes small amounts of inert gases are left in the tubes to increase their efficiency. Another improvement was to place the plate and filament as close together as possible.

The DeForest tube was called a triode because it had three electrodes; the plate, the cathode or emitter, and the control grid. Modern tubes have anywhere from two to five elements and special applications even more. The tetrode (four electrodes) has another grid called the screen grid, located between the control grid and the plate. The pentode has another grid between the screen grid and the plate. These extra grids reduce inter-electrode capacitance and increase the frequency range in which the tubes can operate. Tetrodes and pentodes are often used in radio receiving sets.

There are many special kinds of vacuum tubes. Among these are the thyratron, ignitron, tungar rectifier, klystron and the magnetron. The thyratron not only changes the current, but also regulates. It is often used to dim lights in large theaters. The ignitron is used to develop high current at low voltages for welders. The tungar rectifier is a device used in charging automobile batteries. The magnetron and klystron are used to generate ultra-high-frequency waves such as those used in radar.

These are a few facts about electronics and electron tubes that show the importance of electronics in the modern world. Every day progress is being made finding new uses for electronics.

Softly, Softly, Catch the Monkey

by JOHANNES EERDMANS

President, Jaguar Cars Inc.

Soft spoken Johannes Eerdmans, dynamic president of Jaguar Cars Inc., is an outstanding example of his philosophy in action. Born in Bolsward, Holland, he worked for his father, a manufacturer of woolens, from 1924 to 1928. At that time, he joined the Philips Radio Corporation in Eindhoven where he quickly rose to the rank of chief buyer. In 1936, he formed his own import firm in England. After successfully building it up and selling out, he allied himself with the Formica Company in Cincinnati, receiving rights to manufacture and sell their products in Europe, Africa, Australia and New Zealand.

In 1952, at the request of Sir William Lyons, he came to the U. S. to study Jaguar's interests in the Western Hemisphere and to make recommendations for Jaguar distribution and sales here. As a result of his recommendation, Jaguar Cars Inc., was formed. Presently, it accounts for almost half of all Jaguar sales.

Indicative of Mr. Eerdmans' character are two of his favorite sayings, enunciated with a slight Dutch accent: "Don't worry" and "It can be done." His employees can't ever remember his raising his voice, even when he is exercising his special gift for reconciling opposing points of view. The only time he has been known to show anger is when someone is slow.

Athletically built, he particularly enjoys golf and, of course, driving his 1959 Mark IX Jaguar. A widely-recognized connoisseur, he is well known among New York restaurateurs who enjoy catering to his educated tastes.

Because of his accent and the existence of a nephew, he jokes, he feels especially well qualified to talk to people like a "Dutch uncle."

People work too hard.

They confuse activity with accomplishment, afraid to slow down or change their ways lest they be suspected of "goldbricking." In reality, most of us do things the hard way—simply because we don't realize that there are easier methods for getting them done. Rudyard Kipling put it more poetically when he said regarding the best method of capturing the Indian symbol of good luck, "Softly, softly, catch the money."

All it really takes to ease your work burden is a fresh point of view, the ability to spot the bottlenecks in your present routine—and eliminate them.

How can you tell if your present approach is correct?

If, at day's end, you can look back with satisfaction to a succession of accomplishments . . . regularly get the things done that you want and hope to . . . don't feel "drained" by 5 p.m., you're doing your job in the right way.

But—if you find yourself shaking your head and admitting that Friday finds you working feverishly on Wednesday's chores . . . you aren't fit company for friend or family in the evening, then it's time to take stock of your procedures.

What follows ought to help you spot your weaknesses and strengths. They are, substantially, the techniques that increased Jaguar sales nearly 50 percent in the last six years.

1. Do you plan your time expenditures as much as possible by using desk calendar pads, memory-jogging notes to yourself, methodical "tickler" files? The man with a plan never has to ask himself, "What's next?" He knows—well in advance.

2. Do you know how to delegate? Few people have mastered the art of separating the things that only they can do from the things that others can. By allowing yourself to get mired down in details, you load the dice against getting the big job done.

3. Do you know how to make a game out of your job? It's perfectly all right to be a clock watcher—provided you use it as a stimulant, not an escape. If you can view your immediate task as a challenge—you against it—instead of a necessary evil that goes with your pay check, you'll have more fun licking it, feel better when it's done.

4. Are you aware of your importance in the overall picture? Two men, working side by side, were asked, "What are you doing?" The first answered, "I'm laying bricks." The second replied, "I'm building a cathedral." Take the trouble to find out *why* you're doing a job and you'll have more respect for it, tackle it with more ambition, finish it with more pride.

5. Do you show a critical interest in your job? While no employer likes an employee who constantly gripes, neither is he content with the man—or woman—who never does. If you have good reason to criticize a procedure or an idea of how to improve something, speak up. Just be sure you have the facts you need before taking up your boss's time. He'll welcome any practical ideas that will make your job easier. Warning: don't make suggestions with a chip on your shoulder. Phrase them like questions ("What do you think of . . . ?") to avoid an I'm-smarter-than-you effect.

(Please turn to page 28)

HUGHES MASTERS FELLOWSHIPS. The Hughes Masters Fellowship Program offers unusual opportunities for academic training leading to a master's degree...and, in addition, provides each fellow with practical experience in the professional field of his choice.

Approximately one hundred new awards will be made by Hughes in 1960 to qualified applicants who possess a bachelor's degree in science or engineering. Additional awards are open to qualified applicants interested in business administration and education.

Hughes conducts extensive research and development in the scientific and engineering fields. Each fellow may elect an assignment while working for Hughes during the summer in such areas as: microwave power tubes, microwave devices, parametric amplifiers, masers, precision frequency sources, infrared detectors, infrared search and track systems, microminiaturization, switching devices, antenna arrays, phase shifters, ferrites and garnets, simulation methods, propagation, language translation, advanced data handling systems, information processing, human factor analysis, and alpha-numeric displays.

Two different Hughes Masters Fellowship Programs are offered. The **FULL STUDY PROGRAM** applicants will receive fellowships to permit them to attend an outstanding university on a full time basis during the regular academic year with a substantial stipend.

In the **WORK STUDY PROGRAM** award winners will attend a university sufficiently near a facility of the Hughes Aircraft Company to permit them to obtain practical experience, in a profession of their choice, by working at the company part time each week. An appropriate stipend will also be awarded.

After completion of the Master's Program, fellows are eligible to apply for **HUGHES STAFF DOCTORAL FELLOWSHIPS**.

The classified nature of work at Hughes makes eligibility for security clearance a requirement for nearly every applicant.

Closing date for applications: January 15, 1960.

How to apply: Write Dr. C. N. Warfield, Scientific Education Department, Hughes Aircraft Company, Culver City, California.

Hughes Fellowship Programs



HOWARD HUGHES DOCTORAL FELLOWSHIPS. If you are interested in studies leading to a doctor's degree in physics or engineering, you are invited to apply for one of approximately 10 new awards in the 1960 Howard Hughes Doctoral Fellowship Program.

This unique program offers the doctoral candidate the optimum combination of high-level study at an outstanding institution plus practical industrial experience in the Hughes laboratories.

Each Howard Hughes Doctoral Fellowship provides approximately \$8,000 annually. Of this amount \$1,800 is for tuition, books, fees, thesis and research expenses. The remainder is the award of a cash stipend and salary earned by the fellow.

Hughes conducts extensive research and development in the scientific and engineering fields. Typical programs include: network analysis and synthesis, semiconductor materials, plasma electronics, communications, computing... and solid state physics, atomic and nuclear physics, tests of the general theory of relativity, chemistry, physical chemistry and metallurgy, information theory, mechanics of struc-

tures, electro-mechanical propulsion systems, and systems analysis. Howard Hughes Doctoral Fellowships are open to outstanding students qualified for admission to graduate standing. A master's degree, or equivalent graduate work, is considered very desirable before beginning the Fellowship Program.

The classified nature of work at Hughes makes eligibility for security clearance a requirement for nearly every applicant.

Closing date for applications: January 15, 1960.

How to apply: Write Dr. C. N. Warfield, Scientific Education, Hughes Aircraft Company, Culver City, California.

*Creating a new world
with ELECTRONICS*

HUGHES

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Faculty Page

ROBERT LYLE DEDRICK is one of the most recent newcomers to the faculty in our School of Engineering. Although he was born in Madison, Wisconsin, he moved to the Washington area when he was very young. He grew up in the area and attended Wilson High School. Dedrick enrolled at Yale, from which he obtained his Bachelor of Engineering degree. Later he matriculated at the University of Michigan and received his Master of Science in Engineering degree.

As far as teaching is concerned, this is his first appointment. This semester he is teaching several courses in civil and mechanical engineering.

During the summers while he was attending school, Dedrick was employed by various organizations. His engineering experience includes employment with such concerns as Dupont Experimental Station in Wilmington, Delaware, and the National Bureau of Standards here in Washington. In addition, until last July he worked at the Wright Air Development Center.

As an outdoors man, Dedrick enjoys such hobbies as fishing, canoeing, and camping.

He is married and has one daughter.



CLIFFORD D. FERRIS is another newcomer to the teaching staff in the School of Engineering. He was born in Philadelphia, Pennsylvania, and grew up there. Ferris attended the University of Pennsylvania, where he received his Bachelor of Science degree and went on to receive his Masters of Science degree in Electrical Engineering.

While he was attending the University of Pennsylvania, he spent two years working in the Electromechanical Research Laboratory. He has also been employed by the Burroughs Corporation and by Melpar, Inc. Although he has taught part-time, his electrical engineering position here at George Washington is his first full-time teaching experience.

Ferris's interests outside of engineering include music and photography.

He is a member of the Institute of Radio Engineers and the American Institute of Electrical Engineers professional societies.

Ferris is married and has no children.





W.E. DEFENSE PROJECTS ENGINEERS are often faced with challenging assignments such as systems testing for the SAGE continental air defense network.

ENGINEERS explore exciting frontiers at Western Electric

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Western Electric handles *both* telephone work and defense assignments... and engineers are right in the thick of it. Defense projects include the Nike and Terrier guided missile systems... advanced air, sea and land radar... the SAGE continental air defense system... DEW Line and White Alice in the Arctic. These and other defense jobs offer wide-ranging opportunities for all kinds of engineers.

In our main job as manufacturing and supply unit of the Bell System, Western Electric engineers discover an even wider range of opportunity. Here they flourish in such new and growing fields as electronic switching, microwave radio relay, miniaturization. They engineer the installation of telephone central offices, plan the distribution of equipment and supplies... and enjoy, with their defense teammates, the rewards that spring from an engineering career with Western Electric.

Western Electric technical fields include mechanical, electrical, chemical, civil and industrial engineering, plus the physical sciences. For more detailed information pick up a copy of "Consider a Career at Western Electric" from your Placement Officer. Or write College Relations, Room 200D,

Western Electric Company, 195 Broadway, New York 7, N. Y. And sign up for a Western Electric interview when the Bell System Interviewing Team visits your campus.



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REGISTRATION...



The chore of registration is so much easier when Marie is at the final approval desk.

At a time of year when most everyone else is watching the statistics of: the steel strike, unemployment, the cost of living, the world series, and the stock market, someone managed to unearth the enrollment statistics for the School of Engineering.

Frankly the figures don't look good. The enrollment of undergraduate students has declined about 10.8% from the fall of 1958. The fact that admissions have increased slightly would indicate that the decline is composed of people upon whose head the scholastic axe fell, and people who are seeking greener pastures elsewhere. The increase in tuition is undoubtedly a major factor. At this annual rate the undergraduate enrollment in 1964 will be 328 students. Degree wise the greatest casualties came in the BSE ranks where the decline was 41 students, second came the BEE's with a decline of 24 students. The EE's still dominate with about 49% of total enrollment.

New admissions, people who have never been to college before, have increased in all degree categories except the EE's who have decreased 22.5%. It is possible that freshmen are beginning to see the light.

The comparison of only two years of enrollment figures can hardly be a basis of any significant analysis, but here they are, draw your own conclusions.—WAD

UNDERGRADUATE ENROLLMENT

	Fall, 1958	Fall, 1959
<i>Total Students</i>	660	588
BCE	81	82
BEE	315	291
BME	120	118
BSE	132	91
Unclassified	12	6
<i>Total New Admissions</i>	67	73
BCE	10	12
BEE	31	24
BME	10	16
BSE	16	21
<i>Admissions with Advanced</i>		
<i>Standing</i>	48	66
<i>Readmissions</i>	27	30

Source: The School of Engineer, Administration Office.



RCA Electronics introduces the tube of tomorrow

Called the Nuvistor, this thimble-size electron tube is likely to start a revolution in electronics. RCA engineers scrapped old ideas—took a fresh look at tube design. The result will be tubes that are far smaller, perform more efficiently, use less power, can take more punishment, are more reliable. De-

velopmental models now being tried out by designers will have a profound effect on the size, appearance, and performance of electronic equipment for entertainment, communications, defense, and industry in the future. It is another example of the way RCA is constantly advancing in electronics.



RADIO CORPORATION OF AMERICA



Our pretty Mech Miss this month is the very active Miss Marjorie Weller, who is enrolled in the Junior College and majoring in math. Margie was born in Baltimore, Md., attended high school in Erie, Pa., and Allegheny College, Pa. She went to work for one year, and then decided to return to college and enrolled at Bob Jones University in South Carolina. Margie transferred to G. W. in the fall of 1958.



She is a member of the Kappa Kappa Gamma sorority, and participates actively in extra-curricular activities. Her hobbies include golf and dabbling in commercial art. While at Allegheny, she reigned as Homecoming Queen, and is presently trying for the same title at G. W.

For the statistically minded, Margie is a blonde with green eyes, is 5' 6" tall, weighs 115 lbs., and measures 34-22-34.

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CAMPUS NEWS

ENGINEERS' COUNCIL

The Engineers' Council is the recognized student governing body of the School of Engineering and represents the students in all matters pertaining to student activities. The Council is composed of two faculty advisers and nineteen student members—two elected from each year's class, two from the graduate school, one from each student organization in the School of Engineering, the Business Manager of Mechelecv, the house manager of the Davis-Hodgkins House, and the School of Engineering Representative of the Student Council.

Elections are held each year during the month of April and representatives take office in May for the term of one year. The freshmen get their chance to participate a few weeks after entering school because a special election is held to choose the two Engineers' Council representatives from the freshman class.

The officers of the Council are elected by its members at the first meeting of the newly elected Council. Committees are appointed by the president.

The duties of the Council include liaison between the students and the faculty and the student government of the University, sponsoring extracurricular activities, and making recommendations to the School Administrators on matters affecting the general welfare of the Engineering Student Body. Council sponsored activities are supported financially by the Engineers' Council Fee of \$1.50 per semester paid by each engineering student. The Council also acts as the Board of Publishers of Mechelecv, absorbing the losses and pocketing the profits.

Officers this year and their affiliation are:

President.....A. Ray Howland(Theta Tau)
Vice President.....Wayne Davis
(Senior Class)
Secretary.....Ray Morales (Sophomore Class)
Treasurer.....Jack Petrick (Mechelecv)
Assistant Treasurer.....Herb Wilkinson
(Junior Class)

Other Members are:

Dick Beard (AIEE)
Jerry Peake (IRE)
John Roberts (ASME)
Floyd Mathews (ASCE)
John Howie (Senior Class)
Robert Dunn (Junior Class)
Dan Havens (D.-H. House Manager)
John Wenzell (Freshman Class)
Richard Singer (Freshman Class)
Ray Linck (Student Council Representative)

Faculty advisers:

Prof. B. C. Cruickshanks
Prof. G. C. Weaver

The Sigma Tau, one Shophomore Class, and the two graduate school representatives have not been elected as yet to the Council.



THETA TAU

Theta Tau is a national engineering professional fraternity and is a member of the Professional Interfraternity Conference. The national fraternity was founded at the University of Minnesota in 1904, and the Gamma Beta Chapter was inaugurated here at the George Washington University on March 15, 1935.

Membership is by invitation to students in the School of Engineering who have demonstrated themselves to be sociable, practical, and interested

in fraternal ideals.

General meetings are held on the second Wednesday of each month of the school year, with special meetings being held when needed. Social "get togethers" are sponsored about once a month when traditional events are not held. The fall Banquet and Ball will be held on November 7, and a shrimp feast on November 11.

Theta Tau is represented in most intramural sports. Members participate in touch football, volley ball, basketball, bowling, tennis, golf, and swimming. In addition to its social and recreational events, Theta Tau is continually doing its part to help the School of Engineering. It is now working with the school on Family Day, which is to be held on October 31.

The major officers of Theta Tau this year are:

RegentJohn Roberts
Vice RegentPaul Travesky
ScribeDan Havens
TreasurerMonte Whitham



SIGMA TAU

Sigma Tau, a national honorary engineering fraternity, has 28 chapters in Universities throughout the country, and is a member of the Association of College Honor Societies. Xi Chapter, here at George Washington University, was established on April 18, 1921.

The objectives of the fraternity are the recognition of personal attainment

on the part of engineering students, provision for a working organization for promotion of leadership and interests of the engineering college and courses of study, and the encouragement of fellowship among colleagues in training for the engineering profession.

Membership is by invitation to those men selected from juniors and seniors who rank in scholarship among the upper third of their class, and who possess further qualities of socialibility and practicality.

One of the main contributions of Sigma Tau to students in the School of Engineering is through its Tutoring Committee. The Tutoring Committee exists for the purpose of aiding students in gaining greater proficiency and understanding in courses which might cause them difficulty. Students who are in need of help should call or contact any member of Sigma Tau. Help can be obtained in any course in the engineering curriculum and there is no charge for this service.

Sigma Tau administers, scores and evaluates the Freshman Placement Examinations. The scores of these tests are compared with the student's grades throughout his college career. This examination process is intended to help the student to better understand his needs and to enable the school to be better prepared to meet these needs.

President of Sigma Tau is Carroll M. Horn.

Faculty advisor is Prof. W. W. Balwanz.



A.S.M.E.

Meetings of the Student Section of the A.S.M.E. are held on the first wednesday of each month in Room 205 of Tompkins Hall. A variety of programs are presented at these meet-

ings, including movies, lectures from engineers in the field, and student papers presented in competition for cash awards. Student papers may be given on any interesting engineering subject and should last between ten and fifteen minutes. Every member is encouraged to present at least one paper each year.

Membership may be held by candidates for degrees in Mechanical Engineering and Bachelor of Science in Engineering. A five-dollar fee per year is charged to persons applying for national membership. A one-dollar fee, however, is offered to freshmen and sophomores.

The next meeting will be held on November 4, and all ME's are invited to attend. Refreshments will be served.

Officers of the A.S.M.E. for the coming year are:

Chairman	.....	Dave Anand
Vice Chairman	.....	Ed Cutler
Secretary	.....	Guy Jones
Treasurer	.....	Henry Mayo
Engineers Council Rep.	.....	John Roberts



A. S. C. E.

The first regular meeting of the student chapter was held on Wednesday evening, October 7, 1959, in room No. 201 of Tompkins Hall at 8:15 p.m. The meeting was devoted primarily to introductions and the attendance to business which had built up over the long summer months. The evening was completed quite comfortably with the showing of the Bethlehem Steel Company's prize film entitled "Men, Steel and Earthquakes." Following the film showing there was a cordial gathering centered around the consumption of much desired refreshments.

Listed below is a complete list of the chapter officers for 1959:

President	.....	Jim Crist
V. President	.....	Mike Gall
Rec. Secretary	.....	Vince Rice
Treasurer	.....	Tom Miller
Corres. Secretary	.....	Charles Cartrell
Eng. Council Rep.	.....	Floyd Matthews
Faculty Advisor	.....	Dr. R. A. Hechtman
Sr. Contact Member	.....	T. Ritchie Edmonston

The regular monthly meeting of the National Capital Section of A.S.C.E. was held on October 13, 1959 at the Cosmos Club. One feature of this meeting was the annual presentation of student chapter awards by the National Capital Section. Recipient of this award from G. W. U. was Arnold Lee Snyder, Jr. Lee has served the chapter most commendably as our immediate past Recording Secretary and our current Program Chairman. Congratulations from the Chapter, Lee.

In the way of programs, Lee has arranged for November to be our month devoted to the booming highway construction activities. In this field of civil engineering our program chairman has tentatively arranged for a noted highway engineer to speak at our regular November meeting. The meeting is to be followed up by a field inspection trip to a construction project now in progress in the Washington area. Watch for further information about this on bulletin boards located around Tompkins Hall.

November A.S.C.E. Meeting

Wed., November 4, 1959

Room 201, Tompkins Hall

8:15 P.M.

Bring at least one friend.



AIEE—IRE

The meetings of the Joint Student Branch of the IRE—AIEE are held regularly on the first Wednesday of each month. The speaker at the October 7 meeting was Dr. Herbert Friedman, Superintendent of Atmosphere and Astrophysics Division of Naval Research Laboratory. Dr. Friedman gave an excellent talk on the timely topic of "Rocket Astronomy". His talk was illustrated with slides and with a color movie of rocket launchings. The next speaker is Mr. Michael F. Bondy of RCA. Mr.

Bondy will speak on Micro-Modules. The Micro-Modules have shrunk the size and weight of the electronic equipment to a small fraction of those of the relatively bulky equipment used previous. Come to the next meeting and hear about this amazing new technique in electronic packaging and design.

Below is a list of the officers of the AIEE-IRE for the 1959-1960 school year.

Chairman..... Leon H. Sibul
Vice-Chairman..... James E. Jennings
Treasurer..... Robert L. Sanborn
Secretary..... Richard L. Potterton
IRE Secretary..... Donald C. Lockerson
AIEE Secretary..... David T. Lockerson
Faculty Advisors..... Prof. George Abraham,
Dr. Norman B. Ames

The schedule for the coming school year is:

Wednesday, Oct. 7, 1959
Speaker: Dr. Herbert Friedman, Naval Research Laboratory.
Topic: Rocket Astronomy.
Wednesday, Nov. 4, 1959
Speaker: Mr. Michael F. Bondy, Radio Corporation of America.
Topic: The Micro-Module Program.
Wednesday, Dec. 2, 1959
Speaker: Mr. Myron Moore, Federal Power Commission.
Topic: Transport of Energy with Special Reference to E.H.V.

The Faculty of the School of Engineering has provided for the recognition of meritorious scholastic achievement by the display and publication of an Honors List. The students whose names appear below have met all requirements established by the Faculty for this honor. On behalf of the Faculty, it is my pleasure to extend congratulations to these superior students.

As a matter of possible general interest, the Honors List contains "... in alphabetical order, the names of candidates for an undergraduate degree in engineering whose scholastic achievement satisfies all of the following requirements.

- a) The candidate's cumulative quality-point-index is equal to or exceeds 3.00.
- b) At least 30 semester hours credit has been earned as a degree candidate in the School of Engineering.
- c) At least 15 (part-time students) or 30 (full-time students) semester hours credit in an engineering degree curriculum has been earned in the immediate two consecutive semesters.
- d) No grade below "C" has been received during the qualifying period stated in (c) above.
- e) No disciplinary action has been taken in respect to the student."

HONORS LIST SPRING SEMESTER 1959

Bennett, Roland K.	Rendler, Norbert
Carlaroo, John R.	Santilli, Walter G.
Denison, Lawrence M.	Schuler, Bernard C.
Eddins, Donald L.	Sibul, Leon H.
Gilliland, Kitt	Snyder, Arnold L., Jr.
Golab, Thomas J.	Thau, Stephen A.
Grossman, Ronald A.	Treynor, Paul E.
Lokerson, David T.	Tsakos, Steven
Mayo, Henry C.	Wilkinson, Herbert S.
Oscar, Paul A.	Williams, John H., Jr.
Perazich, William	
Potterton, Richard L.	Yee, Kenneth W.

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Please send me your free student portfolio on Asphalt Technology.

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CITY _____ STATE _____

SCHOOL _____



TRAFFIC CONTROL

(Continued from page 5)

keep them in step without any interconnecting wires other than the power lines. A controller may be interconnected with a master controller by the use of additional relays, terminals, and interconnecting cables.

The coordination system most frequently used is the progression or a progressive system. This system consists of two or more adjacent intersections with the signals so timed that a vehicle may start at one end of the system and proceed through the entire system without stopping, by assuming the predetermined constant speed at which the system has been set. The basic time for one cycle is 80 seconds under this system in downtown Washington, D. C.

The master controller for the traffic system of the District of Columbia is located in the Municipal Building. It changes the timing of the 3450 traffic signals in the District three times a day. Different systems are used for the morning rush, mid-day calm, and afternoon rush. The controller also checks each traffic light for coordination with the others every 80 seconds, sets signals on flashing red or amber at night, and turns off other lights at night.

The controller consists of a seven day program clock, program drum, and relays. Ten times a day the program clock causes the program drum to advance one notch. The program has small pins on its circumference which close electrical contacts. The electrical contacts operate relays which send impulses to secondary controllers at the intersections to be regulated. A seven-wire cable is used to interconnect the controlled intersections with the master. The voltage drop in the cables require that 22 boosters be used to overcome this drop.

There are 15 independent sections in the District of Columbia. Independent sections consist of a number of intersections, not connected to the master controller. These intersections are too far from the master to warrant connection by cable, but must be interconnected for control of traffic. These intersections are interconnected with each other in their own independent section.

WARRANTS

In order to provide a general yardstick in determining the merits of a given traffic situation relative to signal control, warrants have been developed to fit a number of local conditions. The set of warrants for the District are given in these six conditions. At least one of these warrants must be met:

1. An average 1000 vehicle an hour entering the intersection during the day. Of these, 250 must be from the minor street.
2. An average volume to 300 pedestrians per hour in day-time crossing the major traffic stream of at least 750 vehicles.

3. Five or more reported accidents at the intersection within a year. These must be of a type susceptible to correction by traffic signals.

4. The lights to be installed must be needed to provide a break in the traffic flow so pedestrians and vehicles at near-by unlighted intersections can cross safely.

5. Coordinated movement of traffic: These signals are installed to keep traffic on a main street in groups.

6. A combination of warrants nearly satisfied, plus predominance of older people or children using the intersection.

The traffic control system in the District of Columbia is simple, but efficient. Although the system has been in operation for over 20 years, it is still effective.

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This type of system still controls most of the lights in Washington, D. C. at the present, but is being replaced by a more modern electronically controlled system. (ed. note.)

MATRIX ALGEBRA

(Continued from page 7)

g) replace row "1" by row "1" plus two times row "2"

$$G = \begin{bmatrix} 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 2 \\ 0 & 0 & 1 & 3 \end{bmatrix}$$

Hence $x=1$, $y=2$, $z=3$, and by inserting the values in the original equations it is seen that, indeed, they are the solution to the equations.

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VIBRATIONS

(Continued from page 9)

and from equation 7, the natural frequency of the strip will be:

$$(22) \quad f = \frac{5.42}{1\sqrt{\frac{EI}{W_1}}}$$

If the built in edge of the reed is attached to a body vibrating at some frequency, f' , then by adjusting the length, l , of the reed a value can be found such that the amplitude of the vibrating reed is a maximum. This will occur when $f=f'$ and since E , I , and W are known constants and l will be measured, one can easily determine f and thus f' the desired unknown frequency of the vibrating structure. This is the principle of the Fullarton vibrometer. A modification of this instrument (Frahm's tachometer) is to have a number of metal strips whose lengths are pre-fixed so that each strip represents a definite natural frequency. Then the reed that vibrates with the largest amplitude will be the one whose natural frequency is nearest to that of the vibrating structure.

In conclusion, I feel it is of interest to discuss a practical problem involved in the study of vibrations. It has been previously pointed out that in the case of rotating machinery the source of the forced vibrations lies in the unbalance of weight in the rotating parts. It may be the case that the amplitude of these vibrations is of too great a magnitude to allow satisfactory performance of the machine. Therefore, what is often done is to spring couple another body to the machine to act as a vibration absorber. Such a system is shown schematically in figure 4.

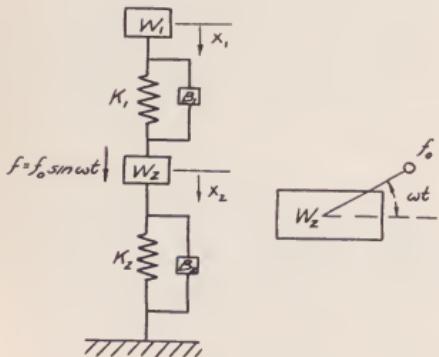


Figure 4

W_2 represents the weight of the large machine which is spring and damper coupled (through its frame and parts) to its foundation. f_0 represents the weight of the unbalanced members rotating at the constant angular speed ω . W_1 is the weight of the vibration absorber which is spring and damper coupled to W_2 . x_2 and x_1 are the displacements of W_2 and W_1 respectively with respect to the foundation. The primary problem is to select suitable values for W_1 , K_1 , and B_1 so that the motion of W_2 is reduced to zero. The mathematical analysis of this system is too long to be presented here, but it can be shown that if $B_1 \approx 0$, then x_2 will be almost zero for $\sqrt{K_1/W_1} = \omega$. If $B_1 \neq 0$, then x_2 will be a minimum if $\omega = \sqrt{K_1 g/W_1 + B_1^2 g^2/2W_1^2}$. The second consideration is whether the resulting motion of W_1 is so great as to cause plastic deformation and thus failure of the spring K_1 . The allowable x_1 will place further restrictions on the values of K_1 , W_1 , and B_1 . A final consideration, but one of equal importance is the transient analysis of the motions of both W_2 and W_1 .

There are many other practical vibration problems in engineering design work. Bridges and railroad tracks under the action of rolling loads, foundations of structures housing vibrating bodies and many other mechanical systems present problems which must be handled by thorough treatment of vibrational analysis. And it is through the use of vibration measuring instruments that this analysis can be carried out.

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SOFTLY, SOFTLY

(Continued from page 15)

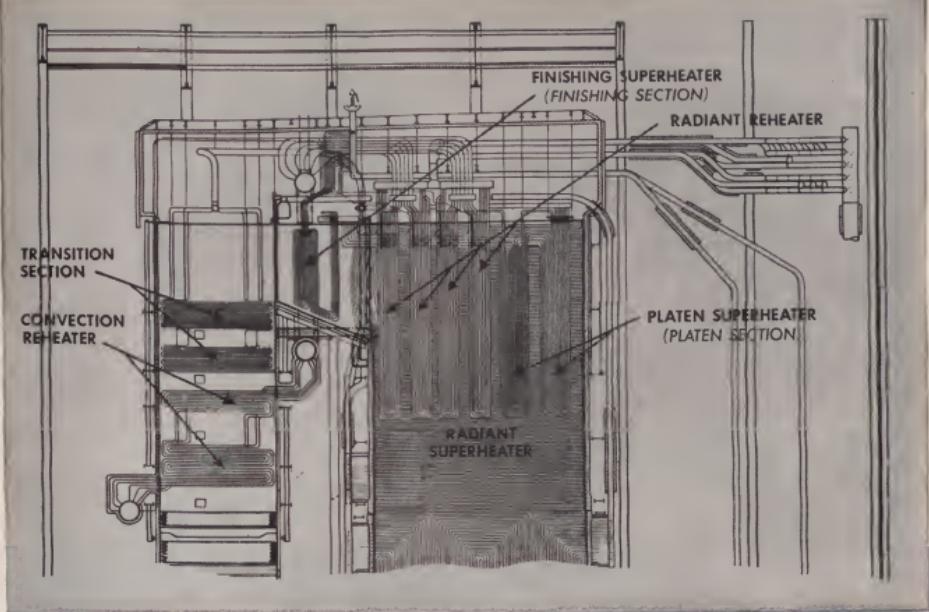
6. Do you listen carefully the first time? By getting all the facts (who, what, when, where, why) first time around, you avoid costly errors, back-tracking, doing things over. Ask questions for clarification, take notes if necessary.

7. Do you know how to "recharge" yourself? You may not be able to take catnaps on your job, but how about: a coffee break . . . a few deep breaths . . . a good yawn and stretch . . . a candy bar for quick energy? Come 4 p.m., any of these pepper-uppers can mean the difference between nothing done and real accomplishment.

8. Do you finish a job before starting another? If you don't, you're creating a psychological block that will make finishing chore No. 1 that much harder when you return to it. Self-discipline isn't easy—at first. Once you achieve it, though, you'll wonder how you ever got along without it.

All of which is just another way of saying, "Softly, softly, catch the monkey."

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MAGNETIC AMPLIFIERS

(Continued from page 13)

which the flux changes from point 0 to point 1. Load current during this portion of the cycle has a low value.

Since the flux cannot change during that portion of the cycle where the operating point travels from point 1 to point 2, almost all of the supply voltage appears across the load, and the load current is determined by the load resistance in this idealized case. The load voltage waveform is approximated by the dotted curve in figure 3.

As the control current changes to establish a new operating point at point A, a smaller and smaller portion of the supply voltage appears across the power winding, and almost all of the voltage appears across the load. Conversely by lowering the operating point to point B, the a.c. supply voltage appears almost entirely across the power winding.

As the control point 0 approaches point A, very little of the positive half cycle of voltage appears across the power line, and almost all of it appears across the load. Hence the average of the load voltage is large. Conversely as the operating point approaches point D, only a small portion of the positive half cycle of voltage appears across the load, and the average value decreases.

If we plotted the d.c. value of the load voltage versus the control winding ampere-turns for a series of values of control winding current corresponding to operating points between a and b, a curve of the following general shape would result.

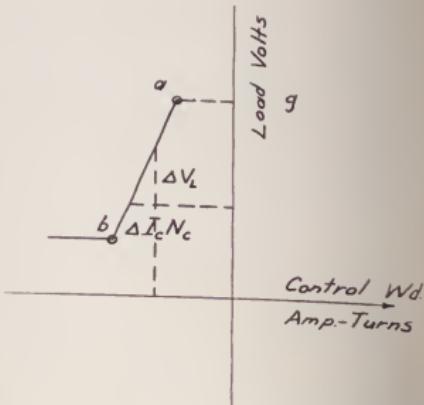


Figure 4

Since the control winding ampere-turns are proportional to the d.c. voltage applied to the control windings, the slope of the curve in figure 4 is an indication of the voltage gain of the amplifier. If we let . . .

V_L = Load Voltage

N_c = No. of Control Winding Turns

I_c = D.C. Control Winding Current

V_c = Control Voltage

R_c = Resistance of Control Winding

then the gain of the device can be expressed as . . .

$$G = \frac{\Delta V_L}{\Delta I_c N_c} = \frac{\Delta V_L}{\Delta V_c} \frac{R_c}{N_c}$$

The half-wave circuit which is shown in figure 1 is seldom used in actual practice. A more practical circuit which utilizes a bridge rectifier and a source of three-phase a.c. voltage is often used.

* * *

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SLIPSTICK

SLAPSTICK

A young engineer took his girl to the open air opera on a beautiful warm evening. During the first act he found it necessary to excuse himself. He asked the usher where the men's room might be.

"Turn left and walk down to the big oak tree and there it is," he was told.

The young engineer did as he was told and in due time returned to his seat.

"Is the second act over yet?" he asked his girl.

"You ought to know," she replied.
"You were in it."

Three men were sitting on a park bench. The man in the middle was sitting quietly as though asleep. But the other two men were going through the motions of fishing. With deadly seriousness they would cast, jerk the lines gently, then swiftly wind their imaginary reels. This went on for some time when a policeman sauntered over, shook the man in the middle and demanded, "Are these two nuts friends of yours?"

"Yes, officer," replied the man.
"Well get them out of here then."

"Right away officer," said the man as he began to row vigorously.

If all the students who make out in the back seats of cars were laid end to end, they would be more comfortable.

An inmate of St. Elizabeth's was watching a farmer work in a field. He called over to the farmer to ask him what he was doing.

"I'm putting manure on my strawberries," replied the man.

"Well, I guess I'm really crazy," mumbled the inmate. "I put sugar on mine."

The girl on the bus had been reading the birth and death statistics. Suddenly she turned to the engineer sitting beside her and said, "Do you know that every time I breathe a man dies?"

"Very interesting," he returned.
"Why don't you try Clorets?"

Little boy watching milkman's horse: "Mister, I bet you don't get home with your wagon."

Milkman: "Why?"

Little boy: "Cause your horse just lost all his gasoline."

Two pint sized "cats" were loitering on the street corner when one said to the other, "How old is you?"

"Ah's five. How old is you?"

"Ah don't know."

"You don't know how old you is?"
"Nope."

"Does the wimmen botha you?"
"Nope."

"You is fo."

A group of prohibitionists looking for evidence of the advantages of total abstinence from liquor were told of an old man of 102 who had never touched a drop of the stuff. So they rushed to his home to get a statement. After propping him up in bed and guiding his feeble hand along the dotted line, they heard a violent disturbance coming from another room — furniture being smashed, dishes being broken and the stamping of feet.

"Good heavens, what's that?" gasped one of the committee members.

"Oh," whispered the old man as he sank exhaustedly into his pillows. "that's Pa. He's drunk again."



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**Interview with General Electric's
Charles F. Savage
Consultant—Engineering Professional Relations**

How Professional Societies Help Develop Young Engineers

Q. Mr. Savage, should young engineers join professional engineering societies?

A. By all means. Once engineers have graduated from college they are immediately "on the outside looking in," so to speak, of a new social circle to which they must earn their right to belong. Joining a professional or technical society represents a good entree.

Q. How do these societies help young engineers?

A. The members of these societies—mature, knowledgeable men—have an obligation to instruct those who follow after them. Engineers and scientists—as professional people—are custodians of a specialized body of fund of knowledge to which they have three definite responsibilities. The first is to generate new knowledge and add to this total fund. The second is to utilize this fund of knowledge in service to society. The third is to teach this knowledge to others, including young engineers.

Q. Specifically, what benefits accrue from belonging to these groups?

A. There are many. For the young engineer, affiliation serves the practical purpose of exposing his work to appraisal by other scientists and engineers. Most important, however, technical societies enable young engineers to learn of work crucial to their own. These organizations are a prime source of ideas—meeting colleagues and talking with them, reading reports, attending meetings and lectures. And, for the young engineer, recognition of his accomplishments by associates and organizations generally heads the list of his aspirations. He derives satisfaction from knowing that he has been identified in his field.

Q. What contribution is the young engineer expected to make as an active member of technical and professional societies?

A. First of all, he should become active in helping promote the objectives of a society by preparing and presenting timely, well-conceived technical papers. He should also become active in organizational administration.

This is self-development at work, for such efforts can enhance the personal stature and reputation of the individual. And, I might add that professional development is a continuous process, starting prior to entering college and progressing beyond retirement. Professional aspirations may change but learning covers a person's entire life span. And, of course, there are dues to be paid. The amount is graduated in terms of professional stature gained and should always be considered as a personal investment in his future.

Q. How do you go about joining professional groups?

A. While still in school, join student chapters of societies right on campus. Once an engineer is out working in industry, he should contact local chapters of technical and professional societies, or find out about them from fellow engineers.

Q. Does General Electric encourage participation in technical and professional societies?

A. It certainly does. General Electric progress is built upon creative ideas and innovations. The Company goes to great lengths to establish a climate and incentive to yield these results. One way to get ideas is to en-

courage employees to join professional societies. Why? Because General Electric shares in recognition accorded any of its individual employees, as well as the common pool of knowledge that these engineers build up. It can't help but profit by encouraging such association, which sparks and stimulates contributions.

Right now, sizeable numbers of General Electric employees, at all levels in the Company, belong to engineering societies, hold responsible offices, serve on working committees and handle important assignments. Many are recognized for their outstanding contributions by honor and medal awards.

These general observations emphasize that General Electric does encourage participation. In indication of the importance of this view, the Company usually defrays a portion of the expense accrued by the men involved in supporting the activities of these various organizations. Remember, our goal is to see every man advance to the full limit of his capabilities. Encouraging him to join Professional Societies is one way to help him do so.

Mr. Savage has copies of the booklet "Your First 5 Years" published by the Engineers' Council for Professional Development which you may have for the asking. Simply write to Mr. C. F. Savage, Section 959-12, General Electric Co., Schenectady 5, N. Y.

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